

A Revision of the Genera and Species of the Branchiostomidæ.

By

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(From the Laboratory of the Linacre Professor, Oxford.)

With Plates 34 and 35.

THE opportunity of examining a number of species allied to the well-known Cephalochordate *Amphioxus lanceolatus* was afforded to me by Professor Lankester, who had for some time collected material for the purpose of revising the genus, and suggested that I should go over the specimens in his possession, and prepare a series of drawings showing the chief characteristics of the species. The drawings have been executed by Mr. Bayzand from rough ones prepared by me.¹

The material examined by me is as follows :

1. Various collections from the Zoological Station, Naples (*A. lanceolatus*).
2. Eight specimens from Ostend sent to Professor Lankester by Professor van Beneden of Liège (*A. lanceolatus*).
3. A collection of about one hundred and fifty specimens from the South Australian coast, presented to the Oxford Museum by Professor Baldwin Spencer of Melbourne, Victoria (*H. Bassanum*).
4. A collection of about ninety specimens from Torres Straits, lent to Professor Lankester by Professor Haddon of Dublin, by whom they were collected (*H. cultellum*).

¹ The present memoir must be taken as superseding a note published by me in the 'Reports of the British Association,' 1894, Oxford meeting.

5. Four specimens from Ceylon collected by Mr. Haly, and lent to Professor Lankester by Professor Haddon (*H. cingalense*).

6. Eight specimens from the coast of Brazil, presented to Professor Lankester by Professor van Beneden of Liège (*A. caribæus*), by whom they were collected.

7. Twelve specimens from the Bahamas presented to Professor Lankester by Professor Alexander Agassiz, by whom they were collected (*A. Lucayanum*).

8. Five specimens from Ceylon, forwarded to Professor Lankester by Professor Good Brown, of the National Museum, Washington, U.S.A. (*H. cingalense*).

9. Ten specimens from the coast of California forwarded to Professor Lankester by Professor Good Brown. Cooper's type-specimen of *A. californiensis* was among these.

10. In addition to the above-mentioned material which I have been able to study, and in many cases to examine, by means of transverse sections in Professor Lankester's laboratory at Oxford, I have been allowed by Dr. Günther to examine the specimens of another species (*A. Belcheri*), of which only five exist, in the British Museum.

I am desired by Professor Lankester to express his great obligations to Professors Spencer, Haddon, van Beneden, Agassiz, and Good Brown for their kindness in communicating their specimens to him.

For the nomenclature of the various structures of the Branchiostomidæ already in use the reader is referred to Professor Lankester's memoir (No. 7), and to the recently published work by Dr. Arthur Willey (No. 15).

The characters to which I have, at Professor Lankester's request, given attention, and have found to be important for the purpose of dividing the Branchiostomidæ into genera, subgenera, and species, are as follows. I enumerate the characters approximately in the order of importance which it has been found necessary to assign to them.

1. Præoral cirrhi uniformly connected to one another by a low web, or per contra separated into two ventrad and two

laterad groups, the ventrad groups distinguished by a very high web.

2. A caudal expansion of the median dorsal and ventral fin-ridge present or absent.

3. An unsegmented "urostyloid" caudal region, one seventh the length of the whole animal, present, or per contra only a minute projection of the notochord beyond the last myotome.

4. A single, or per contra a double post-atrioporal cæcum to the atrial chamber.

5. Only the right, or per contra both metapleura continuous with the ventral portion of the snout or rostral fin.

6. The præoral gustatory groove (groove of Hatschek) superficial and shallow, or per contra strongly marked.

7. Fin-ray spaces present or per contra absent in the median ventral fin.

8. Fin-rays developed in the fin-ray spaces of the median ventral fin, or per contra absent.

9. Right metapleur terminating behind the atriopore similarly to the left metapleur; median ventral fin unconnected with metapleura; or per contra right metapleur continued without break into the median ventral fin.

thus, its posterior continuation.

10. Number of tentacles to the oral sphincter (intra-buccal cirrhi) twelve, ten, or sixteen.

11. Gonads developed on both sides of the body, or per contra only on one side.

12. Number of myotomes throughout the body; number of myotomes between snout and atriopore, atriopore and anus,

[N.B.—In counting the myotomes I have reckoned that coincident with the atriopore as belonging to the anterior or præatrioporal group; and similarly I have reckoned the post-anal group as commencing behind the posterior margin of the anus. In many specimens the anus is elongated antero-posteriorly, so as to extend under as many as three separate myotomes.]

13. Proportional height of the median fin.

14. Form of the anterior (rostral) and posterior (caudal) expansions of the median fin.

15. Number and myotomic position of the gonad pouches.

The valuable diagnostic character afforded by the total number of the myotomes, and of the number in the three groups known as præatrioporal, præanal, and post-anal, was first made use of by Sundevall and later adopted by Günther (No. 5), whose essay is up to the present time the most important on the taxonomy of the Branchiostomidæ. During the past year, however, a very important memoir has appeared by Andrews (No. 1) on a Branchiostomid from the neighbourhood of the Bahamas, which presented so many novel features as compared with the forms already known that it was necessary to place it in a new genus, to which Andrews gave the unfortunate name *Asymmetron*. Before the appearance of Andrews' memoir Dr. Arthur Willey had, at Professor Lankester's suggestion, undertaken the examination of Professor Haddon's collection of Branchiostomidæ from Torres Straits, and the result was a short memoir (No. 14) in which some important characters of *B. cultellum*, Peters (of which the entire collection consisted), are pointed out; and the significant suggestion is made that the median ventral fin of the Branchiostomidæ is not truly a median structure, but is the continuation of the right metapleuron. The two papers of Willey and of Andrews made it desirable to re-examine as far as possible all the species of Branchiostomidæ, in order to ascertain whether the peculiar features as to the unilateral character of the gonads, continuity of metapleur and ventral median fin, absence of ventral fin-rays in the one case and of ventral fin-ray chambers in the other, described by these authors, obtain in other forms which had not been looked at by their original describers with these questions in mind. The nature of my work is thus explained. Among the characters made use of, I have added to those introduced into consideration successively by Sundevall, Günther, Willey, and Andrews, only one, viz. the number of the cirrhi or tentacles lying on the inner face of

the oral sphincter (intra-buccal cirrhi), and this I have not determined in every species. Possibly other more skilful observers may be able to render some of the structures examined by me available for specific and generic characterisation, but my own attempts to make use of the position of the atrio-cœlomic funnels, of the skeleton of the præoral cirrhi, of the form of the branchial bars (in section), and of the disposition of Müller's renal papillæ, were unsuccessful.

The drawings given of *B. Belcheri*, *Bassanum*, *californiense*, and *caribæum* are the first which have been published of those species.

The Branchiostomidæ are the sole family of known forms comprised in the branch Cephalochorda of the phylum Vertebrata. Retaining the name Vertebrata for the great phylum to which some recent writers have proposed to apply the name Chordata, Professor Lankester recognises three distinct branches or lines of descent within that phylum, for which in 1877 ('Quart. Journ. Micr. Sci.,' vol. xxvii, p. 450) he proposed the names Urochorda (the Tunicates), Cephalochorda, and Craniata. To these three diverging branches Bateson has proposed to add a fourth, the Hemichorda, to comprise the forms known as Balanoglossus. We may begin the systematic characterisation of the Branchiostomidæ by a definition of the Cephalochorda.

Branch CEPHALOCHORDA, Lankester, 1877.

- LEPTOCARDII, Müller. 'Abhandl. k. Akad. Urss.,' Berlin, 1844,
p. 204.
MYELOZOA, J. Geoff. St.-Hilaire. 1852.
ACRANIA, Haeckel. 'Gen. Morphol.,' 1866.
CIRRHOSTOMI, } Owen. { 'Lectures on Compar. Anatomy,'
PHARYNGOBRANCHII, } 1846.
ENTOMOCRANIA, Huxley. 'Proc. Zool. Soc.,' London, 1876, p. 58.
CEPHALOCHORDA, Hatchett Jackson. 'Forms of Animal Life,'
1888, p. 437.

Vertebrata exhibiting the distinctive vertebrate combination

of the four characters indicated by the terms notochord, pharyngeal gill-slits, tubular myelon, and myelonic eye.

The notochord is large and unconstricted, is continued through the region of the head, and projects beyond the first myotome into the snout or rostrum. The longitudinal musculature of the body-wall is divided by membranous septa into a series of well-marked myotomes. There is no marked enlargement of the anterior region of the myelon as brain, but a slight dilatation of its cavity anteriorly. The myelon terminates anteriorly short of the termination of the notochord; there is no special protective skeleton (cranium) for the anterior portion of the myelon. The vascular system is devoid of a specialised "heart." Minute tubular nephridia, arranged serially, are present. Existing forms exhibit a deep-seated asymmetry, masked by a secondary superficial symmetry; they are of small size, and probably are degenerate representatives of symmetrical bilateral ancestors of more fully elaborated organisation.

Family (unica) BRANCHIOSTOMIDÆ.

AMPHIOXIDÆ, Gray. 'Synopsis Brit. Mus.,' 1842, p. 150.

AMPHIOXINI, Müller. 'Abhandl. k. Akad.,' Berlin, 1844.

BRANCHIOSTOMIDÆ, Bonaparte. 'Cat. metodico Pesci Europ.,' 1846.

AMPHIOXOIDEI, Bleeker. 'Enum. sp. Piscium Archip. Ind.,' 1859.

CIRROSTOMI, Günther. 'Cat. Fishes Brit. Mus.,' vol. viii, p. 513, 1870.

Cephalochorda of minute size, and laterally compressed elongate form—acutely terminated, both anteriorly and posteriorly. The integument is raised dorsally into a median plate or ridge forming the dorsal fin, which is uninterrupted throughout the length of the entire body. Two similar plates or outstanding ridges—the metapleura—exist on either side of the anterior two thirds of the body, which is bluntly triangular in section: the superior angle supports the median fin; the infero-lateral angles support the two lateral plates or metapleura. A median ventral fin is present in the hinder third of the body; in some species it is continuous with the right metapleur, which is also continued in front of the mouth to

join the ventral portion of the rostral fin. The left metapleur is not continued forward into the rostrum, nor more than a short distance behind the atriopore. The gill-slits are numerous and developed on both sides of the pharynx: they do not in the adult present any numerical relation to the metamerism of the myotomes; they open into what is in the embryo a median ventral groove, which subsequently becomes closed in as a canal extending over the anterior two thirds of the ventral wall, and opening by a pore (the atriopore) posteriorly. By later enlargement this canal expands into a considerable cavity (the atrium), separating a lateral region of the body on either side (the epipleura) from the axial region; by similar growth it is extended posteriorly within the body as the single or double post-atrioporal cæcum or cæca of the atrium. The gonads are developed in either or both of the epipleura. A præoral muscular hood is developed in front of the mouth, provided along its circular margin with numerous tentacles, supported by a cartilaginous skeleton; there is one median unpaired tentacle in the median ventral line, and from ten to twenty (according to age and species) on either side.

A single circular area of pigment—the eye-spot—is developed on the inner surface of the median anterior termination of the hollow myelon. A single laterally placed olfactory pit may be present on the left side of the snout, consisting simply of a tubular depression of the epidermis by which it is brought into continuity with a slight upgrowth of the terminal wall of the myelon. The anus is placed on the left side of the ventral fin.

A forwardly projecting cæcum (the hepatic cæcum) is developed on the right side from the alimentary canal at the point where the pharyngeal perforations cease.

The oral sphincter (buccal apparatus) is provided with a series of long sensory intra-buccal cirrhi, which project backwards into the pharynx.

The gonads are developed in a numerous series of cœlomic pouches, corresponding in number and position to the myotomes of the mid-region of the body. There are no genital ducts.

The mid-ventral surface in front of the atriopore is traversed by numerous longitudinal pleats, which permit of the expansion and contraction of this area so as to alter very considerably the volume of the viscera and cavities of the body.

A cartilage-like tissue is developed as skeletal support for the præoral cirrhi, and for the median and lateral (metapleural) fin-plates. In the median dorsal fin, and usually, but not always, in the median ventral fin, this tissue takes the form of separate fin-rays, each contained in a lymph-space or fin-ray chamber; in the metapleura it forms a continuous unsegmented band with a related canal-like lymph-space.

I find it desirable to recognise in the family Branchiostomidæ two genera—Branchiostoma and Asymmetron. The genus Branchiostoma is divided by me into sub-genera—Amphioxus and Heteropleuron.

Genus I.—BRANCHIOSTOMA.

BRANCHIOSTOMA, Costa. 1834.

AMPHIOXUS, Yarrell. 1836.

Præoral tentacles or cirrhi, forming a single series united to one another by a uniformly low intertentacular membrane.

A median ventral tentaculum impar present, the rest symmetrical.

Dorsal and ventral median¹ fins expanded in the caudal region to form a lancet-shaped so-called "caudal" fin, within which the axis of the body terminates.

Fin-ray chambers, with or without enclosed fin-rays, present in the præanal portion of the ventral fin.

Infra-rostral fin continuous with the right metapleur; the left metapleur dying out before reaching the infra-rostral fin.

Atrial chamber produced behind the atriopore into a single tapering cæcum, reaching as far as the anus.

Præoral tentacles provided with numerous sensory papillæ.

¹ Although morphologically the ventral median fin is possibly a portion of the right metapleur, it is convenient to retain the name "ventral median fin" for that continuation of the right metapleuron which lies between atriopore and tail terminus in the mid-ventral line.

Gustatory groove of Hatschek (on the right side of the roof of the præoral hood) shallow.

Sub-genus 1.—AMPHIOXUS.

AMPHIOXUS, Yarrell.

Both metapleura terminate immediately behind the atriopore, and overlap the median ventral fin. The ventral fin-ray chambers form a single median series, each containing a pair of fin-rays, excepting the more anterior and more posterior chambers.

Gonad pouches developed on both right and left epipleura.

1. *Amphioxus lanceolatus*, Pl. 34, fig. 1.

LIMAX LANCEOLATUS, Pallas. 'Specil. Zool.,' x, p. 19.

BRANCHIOSTOMA LUBRICUM, Costa. 'Cenni Zool.,' Napoli, 1834, p. 49.

" " " 'Frammenti Anatomia Comparata,' fas. i, Napoli, 1843.

AMPHIOXUS LANCEOLATUS, Yarrell. 'British Fishes,' 1836, p. 462.

BRANCHIOSTOMA LANCEOLATUM, Gray. 'Cat. Brit. Mus. Fish.,' vol. vii, p. 150, 1851.

Myotomes, maximum number 62, minimum number 58, most frequent 60 (J. W. K. 50 specimens); myotome formula (præatrioporal, præanal, post-anal) 36, 15, 10 (cf. Lankester); 35, 14, 12 (cf. Andrews); 35, 14, 11 (J. W. K.).

Dorsal fin of moderate height, namely, one seventh of the height from the crest of the fin to the free edge of the metapleur at the mid-point of the animal's length.

Snout or rostral fin small and pointed, not marked off from the dorsal fin. Caudal expansion of the dorsal and ventral fin long and lancet-shaped with sharp angles.

Ventral fin with a variable number of median fin-ray chambers, in each of which are two paired fin-rays (excepting those at either end of the series). Thirty-four to forty-one pairs of ventral fin-rays present.

Oral sphincter placed in a line drawn vertically from the apex of the anterior angle of the seventh myotome.

Intra-buccal tentacles of the oral sphincter are twelve in number. Oral hood large; tentacles of the oral hood twenty-one in small specimens to forty-one in the largest specimens. Olfactory pit present.

Gonad pouches twenty-three to twenty-nine on the right side, and twenty-one to twenty-eight on the left side (in fifty specimens, J. W. K.); usually twenty-six on each side.

Average length of fifty specimens (sent from Naples as well-grown) 4.8 cm. (J. W. K.); maximum length 5.8 cm.

Distribution.—Mediterranean Sea, English Channel, North Sea, coast of Norway.

2. *Amphioxus californiensis*, Pl. 34, fig. 4.

BRANCHIOSTOMA CALIFORNIENSE, Cooper. 'Nat. Wealth of California,' 1868, p. 498.

Myotomes, maximum number 73, minimum number 69, most usual 71 (in ten specimens, J. W. K.). Myotome formula 45, 17, 9 (J. W. K.); 44, 19, 8 (J. W. K.); 44, 16, 9 (Cooper's type-specimen, J. W. K.).

Dorsal fin of moderate height; series of dorsal fin-ray chambers extending from the eye-spot to the anal myotome. Rostral fin very small. Caudal expansions of the dorsal and ventral fins long and shallow. Ventral fin with fin-ray chambers and paired fin-rays. Anterior extremity of notochord dipping downwards. Oral hood and circlet of tentacles relatively small in size. Gonad pouches, thirty-one right and thirty-one left.

Oral sphincter underlies the apex of myotome 4. Maximum length of ten specimens 7.4 cm. (J. W. K.).

Distribution.—Coast of California.

Remarks.—This species comes nearest to the *B. elongatum* of Sundevall, the specimens of which are lost. It may be recognised by the relatively small size of the cephalic region; the oral sphincter is placed far forward (myotome 4), and the anus is placed far backward (myotome 62).

3. *Amphioxus caribæus*, Pl. 34, fig. 5.

BRANCHIOSTOMA CARIBÆUM, Sundevall. 'Ofvers. vet. Akad. Forsk.,'
vol. x, 1853, p. 12.

Myotomes, maximum number 61, minimum number 59, most usual number 60 (in eight specimens, J. W. K.). Myotome formula 37, 15, 9; 38, 14, 7; 37, 15, 8 (most usual).

Dorsal fin low—one eighth of the height from the crest of the fin to the free edge of the metapleur at mid-region of body. Fin-ray chambers commence in front of the eye-spot, and extend to myotome 55. Rostral fin marked off from the dorsal fin by a shallow notch, and terminating bluntly in front. Caudal fin small and shallow. Ventral fin low, with fin-ray chambers and paired fin-rays. Oral sphincter underlies the apex of myotome 5, and is provided with twelve intra-buccal cirrhi. Præoral tentacles and gonad pouches as in *A. lanceolatus*.

Maximum length among eight specimens 4 cm. (J. W. K.); according to Sundevall 5.1 cm.

Distribution.—East coast of the United States and of South America; West Indies.

Remarks.—This species stands very near to *A. lanceolatus*. It is distinguished from that form chiefly by the slight development of the caudal fin and the shortness of the post-anal region.

4. *Amphioxus Belcheri*, Pl. 35, fig. 8.

BRANCHIOSTOMA BELCHERI, Gray. 'Proc. Zool. Soc.,' 1847, p. 35.

Myotomes, maximum number 65, minimum number 63 (in four specimens examined in the British Museum (J. W. K.)). Myotome formula 37, 14, 14 = 65 (according to Günther); 38, 17, 10 = 65 (J. W. K.); 37, 16, 10 = 63 (J. W. K.).

Rostral fin well marked, and separated from the dorsal fin by a depression. Notochord dipping downward before its anterior termination. Inferior lobe of the caudal fin relatively large.

Other characters apparently as in *A. caribæus* and *A. lanceolatus*.

Maximum length among four specimens 5 cm. (J. W. K.).

Distribution.—Coast of Borneo (Sir Edward Belcher); Prince of Wales Island, Torres Straits (Dr. Coppinger).

Remarks.—The only known specimens of this species are preserved in the British Museum, Natural History.

Sub-genus 2.—HETEROPLEURON.

HETEROPLEURON, J. W. K., sub-genus nov.

The left metapleur terminates immediately behind the atrio-pore; the right is directly continued without interruption into the median ventral fin.

Ventral fin chambers with or without fin-rays.

Gonad pouches limited to a single series, which is developed on the right epipleur.

Intra-buccal cirrhi sixteen in number.

1. *Heteropleuron Bassanum*, Pl. 34, fig. 6.

BRANCHIOSTOMA BASSANUM, Günther. 'Report Zool. Coll., H.M.S. "Alert," 1884, p. 31.

Myotomes, maximum number 78, minimum number 70, usual number 75 (in 50 specimens, J. W. K.).

Myotome formula 43, 16, 12; 44, 14, 17; 45, 17, 15; 45, 16, 14 (usual).

Dorsal fin shallow. Rostral fin large, and marked off from the dorsal fin by a dip. Caudal fin long and low, the superior and inferior angles entirely removed (as compared with *A. lanceolatus*). Ventral fin with fin-ray chambers and paired fin-rays. Præoral cirrhi from 31 to 33 (in specimens examined). Olfactory pit present. Oral sphincter underlies apex of seventh myotome. Intra-buccal cirrhi sixteen in number. Gonads 26—31, only present on the right epipleur.

Maximum length of 50 specimens 4.3 cm. (J. W. K.).

Distribution.—Bass's Straits, Australia.

Remarks.—The specimens of *H. Bassanum* sent by Pro-

fessor Baldwin Spencer were in an excellent state of preservation. They all show a greater compression of the body from side to side, i. e. less thickness, than do similar specimens of *Amphioxus lanceolatus*.

Although the gonad pouches develop on the right epipleur, they extend when ripening across the median line of the body, so as to be visible through the left epipleur.

2. *Heteropleuron cingalense*, n. sp., Pl. 35, fig. 7.

Myotomes, maximum number 64, minimum number 61 (in eight specimens, J. W. K.).

Myotome formula 39, 17, 6; 39, 17, 8; 39, 16, 8; 38, 17, 8.

Dorsal fin low (one eighth of height from crest of fin to edge of metapleur at mid-body). Rostral fin small, not marked off from dorsal fin. Ventral fin with fin-ray chambers and paired fin-rays. Oral sphincter underlies the apex of the fourth myotome. Intra-buccal cirrhi not determined. Gonad pouches twenty-five, only present on the right epipleur.

Maximum length of eight specimens 3 cm. (J. W. K.).

Distribution.—Coast of Ceylon.

Remarks.—Four of the specimens examined by me were collected by Mr. Haly, and supplied to Professor Lankester by Professor Haddon. Three of these gave the myotome formulæ 39, 17, 8; one (that figured) gave 39, 17, 6. Five specimens were lent to Professor Lankester by Professor Good Brown from the United States National Museum. Of these, one appears not to belong to this species at all, and, in fact, belongs to the sub-genus *Amphioxus*. The remaining four presented the myotome formula 39, 16, 8; 38, 17, 8; and 37, 15, 9. From these facts I think it is clear that there is a Cingalese *Heteropleuron* distinct from *H. Bassanum*, from which it differs chiefly in its smaller number of myotomes. Whether the specimen of *Amphioxus* included amongst the specimens sent from the United States National Museum indicates a distinct Cingalese species of the sub-genus *Amphioxus*, or is referable to *A. Belcheri*, I prefer to leave an open question.

3. *Heteropleuron cultellum*, Pl. 34, fig. 2.

EPIGONICHTHYS CULTELLUS, Peters. 'Monatsbericht der k. Preuss. Akad. der Wiss.,' Berlin, 1876, p. 322.

BRANCHIOSTOMA CULTELLUM, Günther. 'Report Zool. Coll. H.M.S. "Alert,"' 1884, p. 32.

" " Willey. 'Quart. Journ. Micros. Sci.,' vol. xxxv, 1894, p. 361.

Myotomes, maximum number 56, minimum number 50, usual number 52.

Myotome formula 32, 10, 10; 32, 12, 8; 33, 10, 10; 34, 11, 10; 32, 10, 10 (usual number in thirty specimens).

Dorsal fin of great height, especially in the anterior region, where it is more than one third of the total height from fin crest to metapleur edge. The rostral fin is short and deep, and is not marked off by a notch from the dorsal fin. The ventral fin presents fin-ray chambers, which do not, however, ever contain fin-rays, either single or double. (Willey first observed this, and I can confirm him.)

The caudal fin is lancet-shaped, but not strongly marked.

The oral sphincter underlies the angle of myotome 6; there are sixteen intra-buccal cirrhi. The præoral tentacles are from forty-one to forty-three in number (in the specimens examined). The notochord is slightly depressed in the rostral region, and, instead of tapering to its anterior extremity, is expanded to form a club-like termination. Posteriorly the notochord projects beyond the last myotome more than it does in other species of *Heteropleuron* or *Amphioxus*, and terminates bluntly. The gonad pouches are from seventeen to twenty in number, forming a series on the right epipleur. The maximum length shown by specimens in Haddon's collection was 3.5 cm. (Willey).

Distribution.—Torres Straits, Australia.

Remarks.—This species differs more from the other species of *Heteropleuron* than any of them do from one another, and differs in features which remove it further than they are from

the sub-genus *Amphioxus*. It would be almost justifiable to place *H. cultellum* in a distinct sub-genus on account of the absence of fin-rays from the ventral fin-ray chambers, the great depth of the dorsal fin, the swollen anterior knob-like termination of the notochord, and the considerable tract of terminal notochord projecting posteriorly beyond the last myotome.

Dr. Arthur Willey (loc. cit.) was the first to draw attention to the unilateral character of the gonadic pouches in *H. cultellum*, and, in fact, to all the points here noted, excepting the number of the intra-buccal cirrhi. Dr. Willey states that the præoral tentacles are devoid of the projecting sensory papillæ which occur in all species of *Amphioxus* and *Heteropleuron*. I find in well-preserved specimens where the epithelium is still present that the sensory papillæ are clearly developed.

Dr. Willey was unable to find an olfactory pit in this species, and I have not found one.

Genus II.—ASYMMETRON.

ASYMMETRON, Andrews. 'Johns Hopkins University Circulars,' June, 1893, vol. xii, p. 104.

Præoral tentacles grouped into ventrad and laterad series by the presence of a very high intertentacular membrane uniting the tentacles of the two ventrad groups, the lateral series having a low intertentacular membrane like that of the whole series in *Branchiostoma*: a median free ventral "tentaculum impar" between the two ventrad groups of high-webbed tentacles.

Dorsal and ventral median fins expanded some distance in front of the caudal extremity, and contracted again along the terminal seventh of the body, so as to leave a narrow caudal or urostyloid process, and no "caudal" fin. Myotomes not developed in the urostyloid process, which is, however, traversed by the notochord and nerve-cord. No fin-ray chambers or fin-rays present in the ventral median fin.

Right metapleur continued without break to join the ventral

median fin (as in *Heteropleuron*); left metapleur dying out immediately behind the atriopore.

Infra-rostral fin in direct continuity with both the right and the left metapleura. Atrial chamber extending behind the atriopore as two laterally paired cæca. Præoral tentacles devoid of sensory papillæ. Gustatory groove of Hatschek (on the right side of the roof of the præoral hood) very deep and pit-like.

Species unica.—A. LUCAYANUM, Pl. 34, fig. 3.

ASYMMETRON LUCAYANUM, Andrews. 'Johns Hopkins Univ. Studies,' 1893, p. 213.

Myotomes, maximum number 69, minimum number 63, usual number 65—66.

Myotome formula 43, 8, 12; 44, 9, 13; 45, 10, 14; 46, 10, 12; usual formula 44, 9, 13.

Dorsal fin of moderate height (one seventh of length from crest of fin to edge of metapleur at mid-body). Rostral fin very slightly developed, either above or below the notochordal rostrum, which, however, is of unusually great length. Ventral fin devoid of fin-ray chambers, and of fin-rays; a few irregular spaces apparently represent the fin-ray lymph-spaces of other genera. Oral sphincter underlies the angle of myotome 8. Ten intra-buccal cirrhi are present. From twenty-one to twenty-nine præoral tentacles were counted. The nine most ventrally placed are separated into two groups of four by a single free median ventrad tentacle; the two sets of four ventrad tentacles right and left of the tentaculum impar present a high intertentacular membrane, by which tentacle 2 (counting the impar as tentacle 1) is united to tentacle 3, 3 to 4, and 4 to 5: the remaining tentacles on either side corresponding to the numbers 6, 7, 8, 9, 10, &c., are free from one another excepting for a low basal connection as in other Branchiostomidæ. All the præoral tentacles are smooth and destitute of projecting sensory villi or papillæ. Gonad pouches twenty-six to twenty-nine, in a single series on the right epipleur.

Maximum length observed in 12 specimens 1.9 cm. (J. W. K.).

Distribution.—Off the Bahamas, pelagic (?).

Remarks.—Several interesting points in the structure of this species are detailed in Mr. Andrews' account (*loc. cit.*). Attention may especially be drawn to the following in addition to those which have been indicated as generic and specific characters. The anus occupies a nearly median position, the ventral fin being here deflected to the right, occupying thus more nearly its true morphological position as right metapleur. The first pair of nerves arise below the eye-spot; in place of the second pair there is a single nerve, which, with the first pair, supplies the rostrum.

In young specimens the urostyle-like process is not developed, and there is a terminal caudal fin.

The terminal branches of the rostral nerves are furnished in all Branchiostomidæ with cellular end-organs; these are of especially large size in *A. Lucayanum*.

Incertæ Sedis.

1. *AMPHIOXUS ELONGATUS*, Sundevall. 'Ofvers. vet. Akad. Förhand.,' 1852, p. 147.

BRANCHIOSTOMA ELONGATUM, Sundevall. 'Ofvers. vet. Akad. Förhänd.,' 1853, p. 12.

Myotomes 79. Formula 49, 18, 12. Dorsal fin low. Caudal fin small. Oral cirrhi wanting. No eye-spot. Length 6 cm.

Distribution.—Coast of Peru.

Remarks.—This species is described as above by Sundevall, but the description does not enable us to determine whether the species belongs to the sub-genus *Amphioxus* or *Heteropleuron*, or to the genus *Asymmetron*, or to a distinct genus. The apparent absence of oral tentacles is very probably due to alcoholic shrinking.

Eigenmann (3) records the capture of a number of Branchiostoma from San Diego Bay, California, which he is disposed to refer to this species, but from his description it appears probable that they belong to the species *A. californiensis*.

2. *BRANCHIOSTOMA PELAGICUM*, Günther. 'Challenger Reports,' vol. xxxi, 1889, p. 43.

Myotomes 67. Myotome formula 36, 16 (?), 15.

Dorsal fin low ; caudal fin paddle-shaped ; ventral fin without fin-rays ; oral cirrhi wanting ; notochord projects beyond the myotomes posteriorly. Nerve-cord with eye-spot ; gonads in two series, twenty-six (?) on either side.

Length 1 cm.

Distribution.—A single specimen taken in the tow-net near Honolulu.

Remarks.—Of this species only the single specimen above described is known. After Dr. Günther's description and figure were published it was examined by Professor Lankester by means of transverse sections, but the state of preservation was such as to render any satisfactory observations impossible. The specimen had been stained strongly in carmine before it came into Dr. Günther's hands, and mounted under a cover-glass which had greatly compressed it.

TABULAR ENUMERATION OF THE GENERA AND SPECIES OF BRANCHIOSTOMIDÆ.

Genus I.—*BRANCHIOSTOMA*, Costa.

Sub-genus *Amphioxus*.

1. *A. lanceolatus*, Yarrell (Pallas).
2. *A. californiensis*, Cooper.
3. *A. caribæus*, Sundevall.
4. *A. Belcheri*, Gray.

Sub-genus *Heteropleuron*.

1. *H. Bassanum* Günther.
2. *H. cingalense*, J. W. Kirkaldy.
3. *H. cultellum*, Peters.

Genus II.—*ASYMMETRON*, Andrews.

1. *A. Lucayanum*, Andrews.

INCERTÆ SEDIS.

1. *Branchiostoma elongatum*, Sundevall.
2. *Branchiostoma pelagicum*, Günther.

Note.—Whilst the three species of *Heteropleuron* seem to be distinctly characterised, it is very questionable whether more than two species of the sub-genus *Amphioxus* should be recognised, namely, *A. lanceolatus* (including *A. caribæus* and *A. Belcheri*) and *A. californiensis*.—E. RAY LANKESTER.

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EXPLANATION OF PLATES 34 & 35,

Illustrating Miss J. W. Kirkaldy's paper, "A Revision of the Genera and Species of the Branchiostomidæ."

All the figures are drawn of the same absolute size, so as to facilitate a ready comparison of the proportions of each species. A line placed above each pair of figures gives the usual length of adult specimens of the species indicated. With the exception of fig. 1, which is copied from originals drawn from living specimens at Naples by Professor Lankester, the drawings have been made from spirit-preserved specimens. In the views from the ventral surface the præoral hood has been represented as expanded, as it would probably appear in life, but in the side views (excepting in fig. 1) the actual condition of contraction of the hood seen in the spirit specimens has been more closely followed, and accordingly the side view is not in this region precisely coincident with the ventral view. The ventral mid-surface is represented as distended as it is in life, so that in the profile views it projects below the metapleur. It would be as easy as it is desirable to have drawings from the life of the South Australian *Heteropleuron Bassanum* and of *Amphioxus californiensis*.

FIG. 1.—Ventral and profile views of *Amphioxus lanceolatus*, Pallas, copied from Lankester (No. 7) with the addition of a tentaculum impar to the oral hood. The animal is represented as seen in life in a basin of water lying on its back (upper figure) or on its side (lower figure), with the præoral hood and tentacles expanded, the atrial chamber distended, and the atriopore widely open.

FIG. 2.—Ventral and profile views of *Heteropleuron cultellum*, Peters. Præoral hood contracted in the profile view.

FIG. 3.—Ventral and profile views of *Asymmetron Lucayanum*, Andrews.

FIG. 4.—Ventral and profile views of *Amphioxus californiensis*, Cooper. In the profile view the præoral hood is represented as much contracted as it is in spirit specimens.

FIG. 5.—Ventral and profile views of *Amphioxus caribæus*, Sundevall. In the profile view the præoral hood is incompletely expanded.

FIG. 6.—Ventral and profile views of *Heteropleuron Bassanum*, Günther.

FIG. 7.—Ventral and profile views of *Heteropleuron cingalense*, Kirkaldy. Præoral hood in the profile view only partially expanded.

FIG. 8.—Ventral and profile views of *Amphioxus Belcheri*, Gray. In the profile view the præoral hood is not nearly so fully expanded as in the ventral view.